THE CONTRIBUTIONS OF DIGITAL CONCEPT MAPS TO ASSESSMENT FOR LEARNING PRACTICES

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ABSTRACT

We have been developing a digital concept maps website (www.conceptmapsforlearning.com) based on the principles of effective assessment for learning. The purpose of this paper is to reveal its promising contributions to formative evaluation practices. The website reduces the workload of teachers as well as provides immediate and delayed feedback on the weaknesses of students in different forms such as graphical and multimedia. For the following study, we will examine whether these promising contributions to assessment for learning are valid in a variety of subjects.

KEYWORDS

Concept Mapping, Digital Knowledge Maps, Assessment for Learning, Online Assessment.

1. INTRODUCTION

Assessment is one of the crucial components of education (Gikandi et al, 2011), and is required for three broader aims (Black, 1993):

- The certification of individual student achievement;
- The accountability of educational institutions via the comparison of results;
- Direct assistance to learning through useful feedback.

To accomplish one or more of these purposes, assessments can be designed as either summative or formative. While the main purpose of summative assessment is to categorize students' performance by assigning grades, the basic aim of formative assessment is to identify students' specific strengths and weaknesses in order to facilitate further learning (Cizek, 2010). Assessment for learning is to assess student performance and provide feedback during the process as well as to act on the provided feedback in a way that benefits that student's learning (Trumpower & Sarwar, 2010; Filiz et al, 2012).

1.1 The Effectiveness of Assessment for Learning

Despite the challenges to assessment for learning including resources and time (Cizek, 2010), several studies reveal the positive impact of formative evaluation on students' achievement. For example, Black and Wiliam (1998) concluded that assessment for learning increases students' performance after reviewing around 250 articles based on formative evaluation. These studies were related to feedback, self-assessment, and peer assessment. Likewise, Nyquist (2003) came to a similar conclusion after conducting a meta-analysis on use of feedback for formative assessment purposes. And, in an empirical study of 24 teachers who received six-months of training to develop formative assessment practices, William et al (2004) demonstrated the positive impact of using assessment for learning in classrooms.

However, the generalizability of these findings has been questioned by some. For instance, Bennett (2011) has argued that the mean effect size computed by Black and Wiliam (1998) is based on studies that are too diverse to be meaningfully combined, and that the meta-analysis conducted by Nyquist (2003) was too narrowly focused on the college-level population. Similarly, Dunn and Mulvenon (2009) have raised methodological concerns that may limit the conclusions drawn by Wiliam, et al. (2004). Because of these issues, the specific principles of effective assessment for learning should be further addressed.

1.2 The Principles of Effective Assessment for Learning

Trumpower and Sarwar (2010) have condensed the criteria of effective formative evaluation into four necessary conditions in the context of technology assisted assessment for learning.

Assesses Higher Order Knowledge: The formative evaluation task must allow teachers to assess higher order knowledge of students (Trumpower & Sarwar, 2010). Perkins (1993) notes that lack of higher order knowledge causes misconceptions. Therefore, assessing higher order knowledge is one of the crucial functions of any computer based formative evaluation software. Trumpower et al (in press) noted that concept mapping tasks assess higher order knowledge.

Identifies Specific Strengths and Weaknesses: The formative evaluation task must identify specific strengths and weaknesses of students' knowledge (Trumpower & Sarwar, 2010; Cizek, 2010). There are several ways of doing this. For example, an expert concept map might be given to students to compare with their concept map (Trumpower et al, in press).

Provides Useful Feedback: The assessment for learning task must provide useful formative feedback on students' weaknesses. Shute (2008) reviewed research on formative feedback and identified several criteria of effective feedback, including that it should be simple, objective, provided in a variety of formats other than text, delivered in a timely manner, and give clear suggestions on how to improve.

But, in order for these principles to be effective, students should also be required to reflect on the formative feedback (Fontana & Fernandes, 1994; Frederickson & White, 1997; Boston 2002), and be given opportunities to use it to modify their previous work (i.e., revise and resubmit assignments/test answers).

Is User Friendly: A majority of teachers think that formative feedback is a difficult and time-consuming task (NRC, 1999). Accordingly Trumpower et al (in press), suggest that technology assisted assessment for learning applications should include automated assessment, evaluation, and feedback mechanisms. In addition, these applications should allow students to monitor their performance.

2. BRIEF PRESENTATION OF CONCEPT MAPS FOR LEARNING WEBSITE

In our research lab, we have been developing a concept mapping website (conceptmapsforlearning.com) based on the aforementioned principles of effective formative assessment (Filiz et al, 2012). Within the website, students create concept maps on a particular subject and then receive individualized feedback and associated instructional material (e.g., videos, website links, examples, problems, etc.) based on a comparison of their concept map and a subject matter expert's map. After students study the feedback and instructional material, teachers can track their progress by having them create revised concept maps.

Expert concept maps on a variety of topics (e.g., statistics) are stored in a repository within the website. Teachers using the website can choose from amongst the topics. Students are then provided with the concepts corresponding to the chosen topic and rate the degree of relationship between the concepts in order to generate their concept map. The website then compares each student's concept map with the expert concept map to generate individualized feedback for each student. Feedback is comprised of a visual presentation of the expert concept map superimposed over the student's with any discrepancies highlighted by different types of links. As seen in Figure 1, a black line appears provided that there is a link between two concepts in both the expert's map and the student map (i.e., a *relevant* link). A grey dotted line appears if there is a link between two concepts in the student map, but not in the expert's map (i.e., an *extraneous* link). Finally, a red dashed line appears if there is a link between two concepts in the expert map, but there is no link between these concepts in the student map (i.e., a *missing* link).

In addition to this visual feedback, additional instructional material is provided for any missing links. When students move the mouse cursor over a missing link, a text message appears which explains how the associated concepts are related; these explanations have been provided by subject matter experts, but can be modified by individual teachers using the website. Further, if students double click on a missing link, they are able to access linked instructional material intended to illustrate the ways in which the associated concepts are related (e.g., videos, website links, examples, problems, etc.); again, this material has been provided by subject matter experts, but additional material can be added by individual teachers (Figure 1).

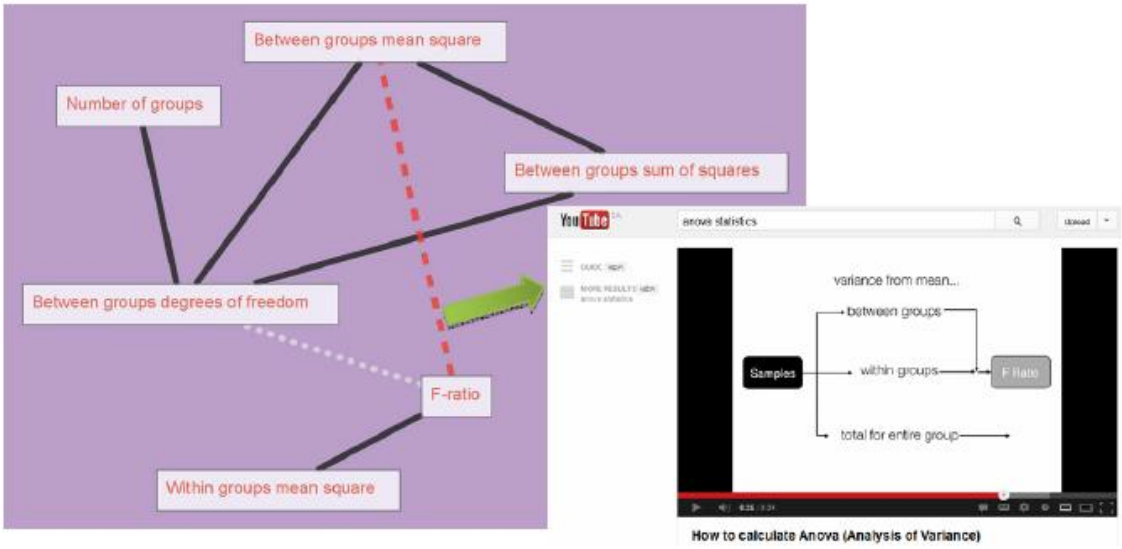

Figure 1. An example of a student's feedback map and an associated linked material

3. HOW DIGITAL CONCEPT MAPPING WEBSITE CONTRIBUTES TO ASSESSMENT FOR LEARNING

One of the crucial contributions of the concept maps for learning website to formative evaluation is to automatically identify each student's misunderstandings and misconceptions. Typically, the task of diagnosing misunderstandings is a difficult one, requiring both specific skills (e.g. how to conduct an interview) and plenty of time for both developing an appropriate assessment task and then for evaluating it (Browning & Lehman, 1988). Conversely, teachers are required to provide very minimal input in the concept maps for learning website. Although they may add their own explanations and linked content, they are only required to choose a topic and submit a list of students for whom they wish to grant access to the website.

Moreover, providing feedback on the weaknesses of students in different forms is another of the crucial contributions of the concept maps for learning website to formative evaluation, for research has shown that students are most likely to ignore verbal and written feedback (Shute, 2008; Lee, 2009). The concept maps for learning website provides both visual feedback and linked feedback as a form of associated learning activities including videos, games, or cartoon.

An additional contribution of the concept maps for learning website is that it is capable of providing immediate feedback. Shute (2008) note that although high-achieving students may benefit from delayed feedback, immediate feedback might be more useful for low-achieving students. The author also reveals that immediate feedback is required for difficult tasks which are associated with higher order knowledge. Therefore, any technology assisted formative evaluation tool must provide immediate feedback.

Furthermore, the concept maps for learning website is most likely to promote equitable education (Gikandi et al, 2011), because each student's weaknesses (misconceptions and/or misunderstanding) and strengths is diagnosed through computer based formative evaluation software. In addition, students are able to study received feedback from a variety of associated instructional multimedia materials.

Finally, our concept maps for learning website may help students improve their general problem solving skills. In a related study, Schacter et al (1999) found that computer based concept mapping tasks improve students' problem solving performance.

4. CONCLUSION

The aim of this paper was to examine how our concept mapping website contributes to assessment for learning practices. Briefly, these contributions are as follows: (1) Assessing students' higher order knowledge, (2) Identifying each student's misunderstandings and misconceptions, (3) Providing delayed and immediate feedback on the weaknesses of students in different forms, (4) Promoting equitable education, (5) Improving problem solving skills

For future studies, we are planning to create more concept maps related to different subjects. Therefore, whether these promising contributions to assessment for learning are valid in different subjects will be examined.

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